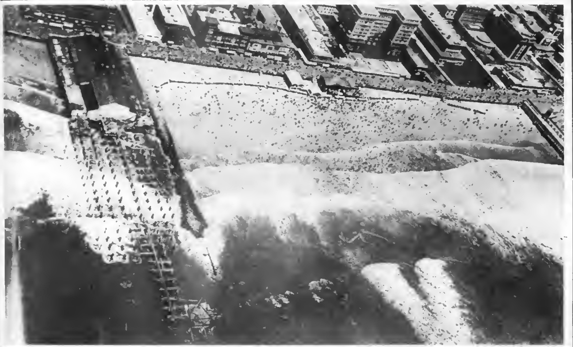
AVIATION

AND

AERONAUTICAL ENGINEERING



Aerial Photograph of Atlantic City's Bathing Beach

SEPTEMBER
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1916

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SPECIAL FEATURES

Aeroplane Shock Absorbers of Rubber
The Mercedes Engine
The Specification of Steel
Course in Aerodynamics and Aeroplane Design
Section 3, Elements of Aerodynamic Theory—*Continued*

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VOL. I. NO. 3

INDEX TO CONTENTS

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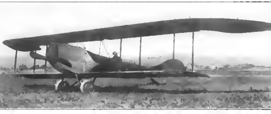
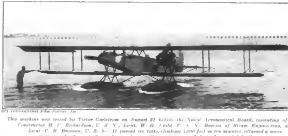
The Christofferson Two Plane Tractor



This aeroplane with its monocoque body is the latest machine of the Christofferson Company

The Curtiss J. N. Twin Hydro



(C) International Film Service, Inc

This machine was tested by Victor Carlstrom on August 21 before the Naval Aeronautical Board, consisting of Naval Constructor H. C. Richardson, U. S. N., Lieut. W. G. Child, U. S. N., Bureau of Steam Engineering, and Lieut. C. R. Bronson, U. S. N. It passed its tests, climbing 5,000 feet in ten minutes, attained a maximum speed of ninety-five miles an hour with a minimum of forty-five and left the water in 150 yards

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AVIATION AND AERONAUTICAL ENGINEERING

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Vol. I September 1, 1916 No. 3

On August 22, for the first time in the history of the United States regular army, aeroplanes passed in review of their commanding officer with troops of other arms. This review was held "somewhere in Mexico" before Brigadier-General John J. Pershing. Long should this epoch making date be remembered and great should be the praise of those making the event possible. But equally interesting is the fact that the machines were efficient for combat service.

The twelve aeroplanes with General Pershing's expedition are all equipped with engines of 160 horsepower or over and have machine guns mounted for immediate service. Every aeroplane carries also two .351 Winchester automatic rifles with 200 rounds of ammunition. Bombs of both an incendiary character and also explosive bombs form part of the equipment, and there are automatic cameras with this squadron. After all the criticism that has been leveled at the aviation arm of the service it is a genuine pleasure to make a record of which every American should be proud.

And the performance of these machines during July gives promise of a brilliant future for the aeronautical squadron. These twelve machines were in the air a total of three hundred and sixty hours, about ten hours a day for a month. This flying was accomplished under the most unfavorable conditions and proves that the many difficulties which were encountered at the outset of the campaign have been overcome.

The problem of suitable propellers has been partially solved by the erection of a propeller factory on the border. Propellers are never used for two reconnaissance expeditions in succession. As soon as a machine returns to its base at Columbus, N. M., the propeller is removed and placed in a humidor to preserve the viscosity of the glue which holds together the laminations and another propeller is taken out and attached to the machine when the time comes for its next flight. Experiments with two, three, four and five-bladed propellers are being conducted.

The propeller problem will also be greatly minimized by gearing down the motors, which is also being done on new machines. Experiments with propellers of steel, and plated blades are being conducted by several important companies. Too much thought cannot be given to this essential factor.

This revolution in the affairs of the aero squadron under General Pershing is chiefly due to the untiring work of Lieut.-Col. George O. Squier, U. S. A., head of the aviation section of the signal corps. He brought to his present assignment a knowledge of conditions abroad and a determination to put aviation in the army on a sound basis. He has done it magnificently. All honor to him.

General Kitchener said "Every aeroplane is worth an army corps." It would be interesting to know the opinion of General Pershing as to the value of an aeroplane to him. As a cavalry officer of the highest reputation knowing the extreme importance of reconnaissance, he must have found in the serviceable aerial equipment furnished him a splendid opportunity for comparisons. It is to be hoped that he will sometime give the country his opinion.

Dep Control Now Standard in Army and Navy

By a recent order of the War Department it is provided that all army aeroplanes are to be equipped with Deperdussin or Dep control systems. These will replace the controls now in use as soon as the army fliers can accustom themselves to the new controls. Two training machines have been ordered for the aviation base at the border, equipped with the old control in one seat and the Dep in the other. By using these machines it is expected that the army fliers can rapidly be taught the Dep system.

Dep control is used exclusively by the Royal Flying Corps of Great Britain and the French flying corps. It has become the standard control used on all types of machines in Europe. Lateral stability is maintained by use of the wheel mounted on a steering column. This column moves forward and back and by this movement the elevating planes are manipulated. Steering is accomplished by pressing with either foot on a rudder bar, the right foot being pressed forward to turn the machine to the right and vice versa.

In the old control system lateral stability was maintained by the pilot swaying his body to right or left, thus moving a shoulder yoke which controlled the wing warping devices. Army pilots complained that this system compelled them to maintain an immobile position and also interfered with them when they wished to look over the side of the fuselage to observe the terrain immediately beneath their machines.

Until recently the Navy used the so-called modified Dep control in which the wing warp and elevator were controlled as in the Dep, but the steering bar wires were crossed so that the right foot was pressed forward to turn the machine to the left. The Navy Department has followed the army's lead in ordering that Dep control be used exclusively on all navy planes.

Notes on Aeroplane Shock Absorbers of Rubber

By J. C. Hunsaker, Eng.D.

The design of rubber shock absorbers or springs for aeroplane landing carriages is very unsatisfactory from an engineering standpoint because of uncertainty with regard to the mechanical properties of the rubber. Rubber is in almost universal use for medium and light weight aeroplanes and there appears to be no other material so well adapted to this particular employment.

It is notorious that landing carriages are easily broken by rough landing, and rule of thumb in design gives no idea of the causes of such failures nor the factor of safety present. Consequently, I have endeavored to compile data upon the mechanical properties of such rubber as is commonly used on aeroplanes, and to apply the results to design.

It appears that the commercial grade of rubber springs on the market is not in every way what one would desire. The elongation permissible is small, which allows only a small travel for the landing gear in which the energy of landing must be absorbed. The shock to the aeroplane is accordingly very severe and it is remarkable that there are not more accidents.

Rubber Manufacture*

Processes of manufacture include the breaking down and washing of the crude rubber, compounding or mixing with reclaimed rubber or shoddy, rubber substitutes, sulphur and mineral fillers, etc. The effect upon the mechanical properties of the finished product of the various compounding materials is the technique of the manufacturer.

R. H. Upson of the Goodyear Tire & Rubber Co. has been so kind as to give me the following classification of the compounding materials in common use:

"(1) Crude Rubber, including hard, medium, soft and very soft, also Gutta Percha, Gutta Siak and Balata. Rubber forms the basis of all good quality rubber goods. The kind or quality of the rubber determines to a large extent the quality of the cured finished article.

"(2) Reclaimed rubber; used mainly as a cheapener or filler. The properties of a reclaim and the properties which it has a tendency to impart to a stock, depend largely upon the kind of scrap from which it is reclaimed.

"(3) Rubber substitutes, used mainly as light gravity fillers.

"(4) Bitumens, tars, pitches, mineral rubber, and asphalt, are all of similar nature. They are used mainly as cheap binders, or to facilitate the processing of the stock, such as mixing and frictioning.

"(5) Resins, used mainly as cheapeners and fillers and exert a binding effect on the dry mineral powders.

"(6) Waxes, ceresin, paraffin, beeswax, ozokerite, used for special purposes such as for obtaining a gas tight film and to obtain special results in hard rubber.

"(7) Fats and oils; cottonseed oil, rosin oil, castor oil, paraffin oil, and vaseline, used mainly to facilitate mixing and handling of the stock.

"(8) Mineral powders, this is such a large class that it should be considered under the following sub-classes, although some of the materials partake of the properties of two or more of these sub-classes.

"(a) Vulcanizing agents, which include sulphur as the only one commonly used. Sulphur Chloride is used in vapor or dip curing.

"(b) Accelerators, which hasten and modify the combination of rubber and sulphur, including lime, magnesium oxide, magnesium carbonate, antimony sulphide, litharge and most other lead compounds.

"(c) Special properties, some powders are added for the special properties which they give the compound. The most important is zinc oxide, with its peculiar toughening properties. Graphite and lamp black also belong to this class.

"(d) Cheapeners or fillers, including whiting, barytes, talc and clays.

"(e) Pigments, which are used principally for the special color they produce, including lithopone, U. M. blue, English vermilion, zinc yellow, lamp black, iron oxide, etc."

In the process of vulcanizing, rubber with which sulphur has been mixed, is heated to a temperature above the melting point of sulphur. The rubber and combined sulphur make a new chemical compound of much greater strength and elasticity which is furthermore less affected by temperature changes than the original crude rubber. The chemical formula for rubber gum is not yet known with certainty but is of the form $(C_{10}H_{16})_x$ and each group $C_{10}H_{16}$ unites with two atoms of sulphur when vulcanized.

There is no standard method for the chemical analysis of rubber. It is usual to remove mechanical impurities and water soluble matter by washing. Then the sulphur, mineral oils, waxes and resins are extracted with acetone. The sulphur content of the extract is found by ordinary methods, and the solid residue, "organic extract" or "corrected acetone extract," is weighed. This resinous matter should not exceed 5 per cent of the rubber in the compound for high grade material.

Mechanical Properties of Rubber in General

In general, we may expect that with the very best grades of rubber and the utmost skill in compounding and vulcanizing the tensile strength of rubber may be about 2000 lb. per sq. in. Such rubber may be stretched to about six times its original length. Ordinary commercial rubbers do not approach these figures.

In any rubber the stress strain curve is not a straight line and hence there is no proper modulus of elasticity, as is the case with metals below their elastic limit. However, for engineering purposes it is sufficient in rough calculations to estimate the general slope of the stress-strain curve assumed to be a straight line. In the design of aeroplane landing carriages, an extension of less than 300 per cent is contemplated for the rubber, and over this range the modulus of elasticity or the slope of the above curve does not change rapidly.

Rubber differs from the metals in having a large "hysteresis factor." That is, when a rubber band has been stretched and the values of load and elongation plotted it is found as the load is gradually removed that the rubber does not contract so rapidly as before and the return curve makes with the first curve a "hysteresis loop" representing work done on the rubber which is not restored. This work lost represents the shock absorbing quality of the rubber. The work lost in hysteresis in low grade heavily compounded rubber may be as much as 70 per cent of the work done upon first elongation. Better grade rubbers show a hysteresis loss of about 40 per cent.

It would appear that the poor grade rubber had the advantage as a shock absorber. However, under repetition of the

* References: Circular No. 38 of the Bureau of Standards, "The Testing of Mechanical Rubber Goods." "India Rubber" by P. Schidrowitz. "Crude Rubber" by H. C. Pierson. "Der Kautschuk und seine Prüfung" by Hinrichsen and Memmler. Also articles in *India Rubber Journal*.

load cycle the hysteresis factor for the heavily compounded stock tends to approach that for the pure gum. Furthermore, the cheaper stock does not stretch so far nor age so well as the other.

After stretching and release, heavily compounded rubber takes a large permanent set which will in time nearly disappear. The pure gum stock has less set, recovers more quickly and has a more stable characteristic curve.

On an aeroplane landing carriage, the rubber takes up the first shock of landing as a suddenly applied load which is quickly removed. On this first cycle the hysteresis loop will be large and the aeroplane will be thrown back with only about half the energy with which it stretched the rubbers. Running over the ground, a rapid succession of bumps will cause the rubbers to go through stress-strain cycles with such rapidity that there is no time for recovery of the permanent set given by the first cycle. The hysteresis factor may now be only 25 or 30 per cent. This is exactly what we desire—a damped spring to take up the minor bumps caused by inequalities in the ground.

Methods of Testing

As there is no standard method for chemical analysis of rubber, so there is no standard method for mechanical testing. Frequently a small straight strip is pulled in the jaws of a testing machine. The rate at which the load is applied and released, number of cycles, etc., have an important effect upon the result.

For aeroplanes, rubber is most commonly employed in the form of a loop or ring. Tests made on a ring show a lower tensile strength than similar tests made on a straight strip of

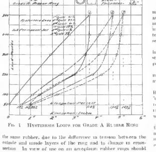


Fig. 1. Hysteresis Loops for Grade A Rubber Ring

the same rubber, due to the difference in tension between the outside and inside layers of the ring and to change in cross-section. In view of use on an aeroplane rubber rings should give better figures for use in design.

Tests at the Bureau of Standards (loc. cit.) showed that the rate of loading has only a secondary effect upon the results of the test. Change of temperature showed somewhat more effect. An increase from 50 deg. F. to 90 deg. F. showed an average 10 per cent decrease in tensile strength, 10 per cent increase in elongation and 30 per cent decrease in permanent set.

In some tests made at the Massachusetts Institute of Technology by Mr. Huff, the actual rubber rings as supplied to aeroplane builders were slipped over ⅜-in. bolts (the size used on the aeroplane) shackled to the head of an ordinary wire testing machine. Temperature for all tests was about

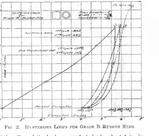


Fig. 2. Hysteresis Loops for Grade B Rubber Ring

70 deg. F., and the load was applied slowly, about 1 in. in 30 seconds.

Elongation and Tensile Strength

Four specimens of "Wright type" rubber rings, grade A, mean diameter 2 in., width 2 in., thickness 5-16 in., broke on an average at 900 lb. per sq. in. and showed an average ultimate elongation of 265 per cent of the initial length. The initial length was reckoned as the half mean perimeter. The tensile strength is computed on a basis of the original cross-sectional area.

Two specimens of the same type and grade of rubber which had been kept in an office for one year showed a tensile strength of 750 lb. per sq. in. and ultimate elongation of 240 per cent. The effect of age seems to be not very serious.

Tests on two specimens of "Farman type" rings, grade A, mean diameter 5.5 in., width 1 in., thickness ½ in., gave as average values 800 lb. per sq. in. and 300 per cent elongation.

Two rings, 2 in. x 2 in. x 5-16 in., made of another grade, B, of rubber (obviously inferior) showed a tensile strength of 725 lb. per sq. in. and an ultimate elongation of only 200 per cent. Thus these rings could only be trebled in length when rupture occurred. To all external appearance these poor rings were no different from the lot first tested.

To the aeroplane designer it is very necessary to know how far the rubbers may safely be allowed to stretch. It will be noted that the best of these rings do not approach the tensile strength of 2000 lb. per sq. in. and an elongation of 600 per cent which we assume good rubber can be made to show.

Hysteresis Loss

The curve of Fig. 1 shows the stress-strain curve for one of the "Wright type" rings for three cycles. The runs were continuous with no time interval to get the exact permanent set.

That given is without waiting more than three minutes for more complete recovery from strain. The hysteresis loss, or ratio of area of loop to area under ascending stress curve is becoming smaller and from 61 per cent for the first cycle is only 41 per cent for the third cycle. The sub-permanent set is almost entirely given by the first cycle and is not great.

Similar hysteresis curves were found for many other specimens, but without material difference in character. The hysteresis losses given above may be taken as representative of commercial aeroplane supplies. Rubbers of this grade are

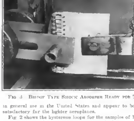


Fig 3 Bridge Type Shock Absorber Ready for Test

in general use in the United States and appear to be fairly satisfactory for the lighter aeroplanes.

Fig. 2 shows the hysteresis loops for the samples of B grade rubber mentioned above in connection with the tests on ultimate strength and elongation. The curve of the first cycle is somewhat startling in appearance, giving a hysteresis loss of about 80 per cent. The sub-permanent set after the first cycle is relatively enormous. For the first blow, this rubber should be an ideal shock absorber were it not for the low tensile strength and small allowable elongation. As a matter of fact, the rubber from which these rings were made was originally developed for bumpers on railroad equipment, where only compression loads are considered. It is not a suitable grade for tension work.

Modulus of Elasticity

As mentioned above, there is no real modulus of elasticity for rubber, but we find useful an approximate figure representing the slope of a straight line which roughly represents the ascending curve of the stress-strain diagram. We have here taken the ascending curve of the first cycle for the computation of E in the expression:

$$f = E\frac{e}{100}$$

where f is ultimate stress in lbs per sq in. E is modulus of elasticity and e is ultimate elongation in per cent of original length.

From tests on Grade A rubber rings, we find E for four specimens 350, 340, 310, 265 lb per sq in. The Grade B rubber, two specimens gave $E = 275$ and 250. For Grade A rubber we may take $E = 300$ as a safe figure. If we compute E for the part of the stress-strain diagram below 50 per cent of breaking load we find an average value of about 250 lb per sq. in.

Test of Complete Shock Absorber

A bridge type shock absorber made for an actual aeroplane was tested by Lts. B. Q. Jones and H. A. Harms, U. S. Army. The general arrangement is shown in Figs. 3, 4, 5. There were fitted 12 rubber rings 2 in. x 2 in. x 5-16 in., similar to those described above in connection with Grade A rubber. Each ring was passed over a 3/4-in. steel pin.

The laboratory report of the test follows:

Department of Mechanical Engineering
Massachusetts Institute of Technology,
Testing Materials Laboratory, Dec 11 19..

HYSTERESIS TEST ON AEROPLANE SHOCK ABSORBER, AND TEST FOR ULTIMATE STRENGTH OF SAME.

Specimen:

Axle—Shelby tubing, 2 in. in diameter by 1/8 in. thick.
Bridge and plate, cold rolled steel, 3/8 in. thick.
Rubbers—Twelve 2 in. by 5-16 in. commercial rubber rings.
Pins—3/4-in. steel.

The Test.

The elongations at the various loadings were obtained by taking the distance (average) between four pairs of center punch marks.

Three runs for hysteresis were made as follows:

First Run— Load, Lbs.	Elongation Ins.	Second Run— Load, Lbs.	Elongation Ins.	Third Run— Load, Lbs.	Elongation Ins.
500					
1 000	.22	1 000	.48	1 000	.51
1 500	.48				
2,000	.78	2 000	1.25	2,000	1.7[illegible]
2,500	1.1[illegible]				
3,000	1.40	3 000	1.98	3 000	2.12
3 500	1.70				
4 000	2.08	4 000	2.45	4,000	2.[illegible]
3,500	2.07				
3 000	1.88	3 000	2.[illegible]	3 000	2.45
2 500	1.83				
2 000	1.57	2 000	1.74	2 000	1.92
1 500	1.10				
1 000	.65	1 000	.[illegible]	1 000	.78
500	.21	500	.23	500	.28

At the beginning of the test with an initial load of 500 lb., the average distance between center punch marks was 2.27 in.

A fourth run was then made for ultimate strength. At a load of 9750 lb., with a corresponding elongation of 5.06 in., the lower bridge failed by buckling under the axle, and one pin at that point failed by shearing off on the inside of the

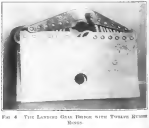


Fig 4 The Landing Gear Bridge with Twelve Rubber Rings.

plate. At the time of the failure there was a pronounced odor of hot rubber, but none of the rubbers failed.

(Signed) B. Q. Jones,
H. A. Harms.

Discussion of Results

Fig 6 is a plot of the three cycles of the hysteresis run. The hysteresis loss drops from 47 per cent to 28 per cent, as would be expected. The sub-permanent set is practically constant at about 10 per cent after the first cycle. For the hysteresis tests the load was run up each time to 41 per cent of the load which ultimately broke the bridge. At this point, 4000 lb., the stress in the rubbers was only 267 lb. per sq in., which appears to account in a qualitative way for a lower

Fig 5 Detail of Construction of Landing Gear Bridge Used in Test

hysteresis loss than we had found for the individual rubbers when carried to a higher stress. In this connection it is of interest to observe that the hysteresis loss is greater for greater elongations.

The initial length of an unstretched rubber is taken as the half mean perimeter or 3.14 in. The bridge failed at a load of 9750 lb., at which point the rubbers had stretched 161 per cent more than the original length and were stressed 650 lb. per sq in. From previous tests these rubbers were found to break at about 900 lb. per sq. in.

The modulus of elasticity computed from $\frac{100f}{s} = \frac{650}{1.61} =$ 400 lb. per sq. in. This is somewhat greater than the highest value, 350, got from tests on individual rubbers. Here again the discrepancy comes from the fact that the rubbers in the two cases were not equally stressed.

The buckling of the bridge before the rubbers were fully elongated shows this landing gear in service might collapse on hard landing. Ordinarily a movement of 5 in. for the shock absorbing mechanism is small.

An aeroplane weighing W pounds striking the ground at V feet per second on a glide of 1 in 7 has kinetic energy to be absorbed by the landing gear of $\frac{W}{2g}\left(\frac{V}{7}\right)^2$. If the machine comes to rest after a motion of x feet, the work done by gravity on it is Wx, and the total energy stored in the shock absorber is $W\left\{x+\frac{1}{2g}\left(\frac{V}{7}\right)^2\right\}$. The average force in the springs is half the maximum F, given by the equality.

$$\tfrac{1}{2}Fx = W\left\{x+\frac{1}{2g}\left(\frac{V}{7}\right)^2\right\}$$

or

$$F = W\left\{2+\frac{1}{xg}\left(\frac{V}{7}\right)^2\right\}$$

If we take ordinary conditions as $V = 66$ ft. per sec. (45 m.p.h.), $F = W(2+\frac{67}{x})$, from which we get the following table for use in design:

x	F
1 inch	68 W
3	23 W
4	17 W
5	13.7 W
6	11.5 W
8	8.6 W
10	6.8 W
12	5.7 W

It appears that the load on the landing gear is nearly 14 times the weight of the aeroplane, if a motion of only 5 in. is allowed. This requires an excessive factor of safety and makes a very heavy construction. Of course, no allowance has been made for the collapse of pneumatic tires which may add 2 in. to the motion of the recoil mechanism.

For our particular gear, failure comes at 9750 lb. for a motion of 5 in. This gear then should not be used on aeroplanes weighing more than $\frac{2 \times 9750}{13.7} = 1425$ lb. total if they are expected to land at so steep a glide and at a speed of 45 miles per hour. The gear is of the type used today on 3000-lb. aeroplanes, and it is clear why their landing requires such delicate handling.

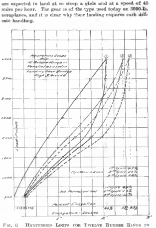


Fig. 6 Hysteresis Loops for Twelve Rubber Rings in Parallel as Used in Landing Gear Bridge, Figs. 3, 4 and 5.

The bridge under test failed by buckling due to insufficient bracing between the webs. This is purely a fault in design and for a very slight increase in weight a bridge of similar type can be made which will develop the full strength of the

rubber. For example, each rubber may be assumed to break for a load of about 1100 lb. after stretching 8.5 in., according to tests made on individual rubbers. Then the maximum load from the previous table is 8.15 W, and the gear could be used on an aeroplane of weight less than

$$W = \frac{24 \times 1100}{8.15} = 3240 \text{ lb}$$

Improved Rubber Required

It is believed that if an improved grade of rubber were developed for aeroplane landing gear, the heavier machines would not now be so difficult to land. For example, if the same 24 rubber rings were made of a grade of rubber which would stretch 12 in. safely, the load on the loading carriage would be only 5.7 times the dead weight, according to our table. Remember that this table is computed on a basis of severe landing conditions. Rubber giving a tensile stress at this elongation only equal to that of the present rings at 8.5 in. elongation would require the same bridge design as before, but the factor of safety in the structure of the landing carriage could be halved with an important saving in weight. Increase in tensile strength of the rubber would permit the use of fewer rubbers, but the saving in weight here would be of less importance. It appears therefore that elongation is more important from the designers' point of view than tensile strength. An increase in the motion allowed softens the shock of landing, permits a less rugged landing carriage as well as many important weight savings in the body and motor foundations.

Bouncing

For very heavy machines, due to the uncertain nature of rubber and the difficulty of fitting a sufficient number of rings, there is an increasing tendency to fit steel helical springs. Also rubber is an unsatisfactory material to keep as a military store on account of rapid deterioration under the action of extremes of temperature, and especially sunlight. Various devices are resorted to in the compounding to reduce this liability to oxidization.

Steel springs are heavier than rubber, but are so easily fitted that the weight of the landing gear need be hardly any heavier than an equivalent gear with rubber springs when the weight of bridges and all attachments is included. However, due to lack of damping in the steel spring, equivalent to the hysteresis loss in rubber springs, it is necessary to fit oil or pneumatic shock absorbing mechanism. An undamped steel spring will throw the aeroplane back up into the air with theoretically the same kinetic energy with which it struck the ground.

For example, the total energy stored in the springs when compressed may be

$$\text{K. E.} = \frac{1}{2}\,\frac{W}{g}\left(\frac{V}{7}\right)^2 + Wx,$$

using the previous notation. If the aeroplane has steel springs the K. E. of the aeroplane when the springs have again extended to their initial length is $\frac{1}{2}\,\frac{W}{g}\left(\frac{V}{7}\right)^2$, the energy of the aeroplane when it first touched the ground. The machine will be thrown into the air a distance of $\frac{1}{2g}\left(\frac{V}{7}\right)^2 = 1.4$ ft. under standard conditions.

With rubber springs showing a hysteresis loss of 50 per cent, the energy returned to the aeroplane is only half of that done on the rubber, or

$$\text{K. E. final} = \frac{1}{2}\left[\frac{1}{2}\,\frac{W}{g}\left(\frac{V}{7}\right)^2 + Wx\right] - Wx$$

$$= \frac{W}{2}\left[\frac{1}{2g}\left(\frac{V}{7}\right)^2 - x\right] = \frac{W}{2}\left[1.4 - x\right]$$

If x, the elongation, is $\frac{1}{2}$ ft the machine is thrown clear of the ground only .45 ft. For an easy landing such as 1 in 11, the machine will not leave the ground after once striking it. The energy of landing is in this case wholly absorbed in the rubber. For smooth ground and a skillful pilot a perfect landing without bounce is the usual thing with rubber landing gear.

On account of the valuable energy dissipating property of rubber, it is doubtful whether, for light aeroplanes, there is any better material. For the heavy machines, over 3000 lb., rubber leaves much to be desired. It would be of interest if a grade of rubber could be produced by the manufacturers which would be described roughly by the following specifications:

Fine Para, at least	45%
Total sulphur, not over	3%
Free sulphur, not over	1%
Acetone extract, about	2.25%
Stretch expected	1 to 6
Tensile strength	1800 lb. per sq. in.
Permanent per cent elongation	25%

Aeronautical Patents

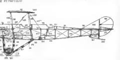
ISSUED AUGUST 15, 1916.

1,194,891. Filed May 31, 1912. To Herbert L. Adams, Somerville, Mass. A parachute life saving device for aviation.

1,194,818. Filed Sept. 7, 1915. To George Roessler, Toledo, Ohio. A variable incidence aerofoil.

1,195,179. Filed July 27, 1912. To Richard R. James, Brooklyn, N. Y. An aeroplane with oscillating wings.

1,195,142. Filed Sept. 21, 1915. To Henry Kleckler, Buffalo, N. Y. Assignor to the Curtiss Aeroplane and Motor Corporation, Buffalo, N. Y. An important patent with numerous sketches of fittings and connections for fuselage construction. The 51 claims cover the application of special fittings to fuselage construction and the connection of the engine bed support directly to the main supporting structure.



ISSUED AUGUST 22, 1916.

1,195,207. Filed Oct. 27, 1913. To Rudolph R. Grant, Norfolk, Va. An aeroplane with inherent stability.

1,195,291. Filed Oct. 9, 1915. To George C. St. Louis, Fresno, Calif. An application of the box kite principle in the aeroplane.

The Mercedes Motor

It is possible to form an excellent conception of the Mercedes motor design from articles that have appeared in foreign contemporary aeronautical journals. A description from an outside view of captured German machines exhibited in London has been given in *Flight* in an article entitled "The Mercedes Engines on the Captured Aeroplanes," and later in *L'Aerophile*, under the title of "Le Moteur d'Aviation Mercedes 150 H. P.". Jean Lagorgette gave a much fuller description that is illustrated with excellent general and detailed drawings. No striking originality is exhibited in the Mercedes motor, the keynote being reliability, simplicity and accessibility with a very solid, very heavy construction.

General Arrangement

In Fig. 1 are shown photographs of the machine captured by the English. This is a somewhat older type, in which the exhaust pipe is attached at the end of the manifold and the old Hazet radiator is placed at the sides. In later machines, as shown in Fig. 2, the exhaust pipe is attached at the mid-point of the manifold and the radiator is of the usual honeycomb type, placed in front of the wings or underneath the front part of the upper wing. The illustrations in the review "Modern German Aeroplanes," that appeared in the August 1 issue of AVIATION, may be referred to.

The exhaust pipe turned up and carried vertically, high above the motor, seems an excellent feature. Shaped as it is, there should not be much back-pressure or head-resistance, and although it is far from being a muffler, it is said to deaden the noise of the exhaust as far as the observers on the ground

FIG. 1. MERCEDES MOTOR ON A CAPTURED GERMAN ALBATROS EXHIBITED IN LONDON

Two engines are described, a smaller 128 horse-power engine used on an Albatros two-seater reconnaissance biplane, and the larger, a 150-160 horse-power engine which is in more general use. The two are of very similar design and we shall deal with the larger engine only.

Main Data and Dimensions

Six cylinder, water cooled.
150 horse power at 1,250 revolutions per minute.
165 horse-power at 1,400 revolutions per minute (limiting speed).
Weight of engine bare, 600 pounds.
Weight of long exhaust pipe, 16.5 pounds.
Weight of carburetor, magnetos, radiator and all piping, 76 pounds.
Weight of cooling water, 55 pounds.
Weight of oil and fuel tanks empty, 55 pounds.
Total weight of engine group, 825 pounds, or 5.5 pounds per horse-power.
Oil consumption, 0.115 pound per horse-power hour.
Fuel consumption is not stated but is probably slightly below the average value for vertical cylinders.
Four-cycle, firing order 1, 5, 3, 6, 2, 4.
Maximum spark advance, 0.475 inch.
Bore, 5.51 inches.
Stroke, 6.30 inches.
Diameter of valves, 2.83 inches.
Maximum lift of valves, 0.18 inch.
Compression ratio, 4.8.
Overall length of engine, 58¾ inches.
Total height of engine, 40¾ inches.
Height above foundation bolts, 27⅝ inches.
Width between foundation bolts, 17⅝ inches.
Maximum width, 19½ inches.

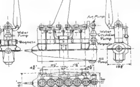


FIG. 2. GENERAL ARRANGEMENT OF SIX-CYLINDER MERCEDES MOTOR.

are concerned. This appears to be a very happy feature of the design.

Figs. 2 and 3 illustrate the general arrangement very well. The cylinders are cast singly. A double carburetor is used, one for each set of three cylinders, and two magnetos. The main shaft is connected by bevel gearing with the vertical shafts. The upper vertical shaft drives the magnetos, the cen-

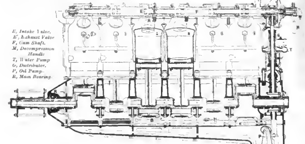


FIG 3. LONGITUDINAL SECTION OF THE 160 H. P MERCEDES MOTOR

trifugal air pump and the horizontal overhead shaft, which in turn is responsible for the exhaust and inlet cams of the overhead valves and for the air pump. The lower vertical shaft is connected to the oil pump which feeds oil into the crank case under pressure.

Cylinders, Valves, Pistons and Connecting Rods

The cylinders, as shown in Figs. 4 and 5, are of cast steel, forged for machining, machined everywhere, with welded sheet steel jackets, and autogeneously welded valve seatings. They are very strong and comparatively light for the single-cylinder type of construction. Complete with springs, valves, water inlets and two plugs, a single cylinder weighs 22.5 pounds.

The valves offer no particular features for comment. The pistons present nothing striking. The cylindrical part of the piston is of cast iron, the rest of steel. The piston rings are 0.137 inch to 0.158 inch thick and 0.195 inch high. The total length of the piston is 4.75 inches, and the total weight, together with rings, gudgeon pins and fixing screws, is 6.8 pounds. The gudgeon pin is hollow and of very large diameters, 1.26 inches outside and 1 inch inside, with a slightly trapezoidal section.

Between the steel gudgeon pin and the small end of the connecting rod is a cast iron ring, perforated in about eight places to permit the free passage of oil and to maintain a reserve. The connecting rod, of I-form, is very strong in spite of its comparative lightness (5.1 pounds). The large end is lightened by perforating the bolts and cap.

Crank-shaft and Crank-case

The crank-shaft and crank-case are shown in Figs. 6, 7 and 8. The crank-shaft rests of necessity on seven bearings, the cylinders being mounted separately. It is very massive and weighs 76.5 pounds complete, with diameters of 2.12 inches for the cranks and 2.2 inches for the bearings. The end bearings are somewhat longer than the intermediate ones.

There are two oil reservoirs, one at each end of the crank-case, which are interconnected by the pump and a pipe of fairly large diameter and covered by finely perforated plates, as in Fig. 6. The oil circulating system will continue to work in whatever be the inclination of the aeroplane. The walls of the aluminum crank-case are very thin, but a very rigid construction is obtained

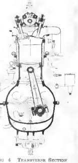


FIG 4 TRANSVERSE SECTION THROUGH ENGINE.

FIG. 5. CYLINDER WITH WATER JACKETS, SPRINGS FOR VALVES AND WATER INLET, OUTLET AND POSITION OF ONE OF THE SPARK PLUGS.

by interesting reinforcements.

From Fig. 4 it will be seen that the crank-case has a species of double bottom, forming a sump, while the fins of the same drawing project under its whole length and, as well as adding considerably to the strength, serve to radiate heat from the oil reservoirs. The partitions shown are also found in the bottom portion of the crank-case. Materially lightened, they do not add much to the weight, but help to strengthen the bearings very considerably.

Cooling System

The centrifugal water pump is also driven from the upper vertical shaft, as shown in Fig. 2. A defect of the cooling system is that the cooled water passes successively from the pump through each of the six cylinders, getting progressively warmer. It is possible that this has no great effect in practice.

FIG. 6. LOWER HALF OF CARBURETOR, SHOWING HOLDING-DOWN BOLTS.

Carburetor

The carburetor as mentioned above, is double. It is made chiefly of aluminum, and the mixing chamber is surrounded by a jacket, through which hot water passes on its way from the cylinder jackets to the radiator. Each carburetor is a two-jet type, the fuel for the pilot jet passing through a choke tube, somewhat as in the Zenith. The air-intake is very unusual, as the air conduit passes through the crank-case from right to left, following the bottom surface of the casing. This warms the air very effectively, but there may be some danger of crank-case fire in case of a blow back into the conduit. At the same time that the air is warmed in this way, it is contributing to the cooling of the oil in the crank-case.

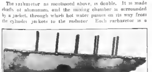


FIG 7 LOWER HALF OF CRANK CASE, SHOWING AIR OPENINGS FOR CARBURETOR

FIG. 8. UPPER HALF OF CRANK CASE IN REVERSE POSITION, SHOWING CRANK SHAFT DRIVE FOR MAGNETOS.

Lubrication System

The oil pump, driven by the lower vertical pump as shown in Fig. 3, forces oil under pressure to all parts of the engine, including the cam-shaft case, is easily dismounted, and avoids the use of all hand-worked pumps. As previously mentioned, the oil consumption is 0.115 pounds per horse-power hour. An interesting table of the oil distribution is available:

0.141 c.c.	Fresh oil to the cam-shaft
0.487 c.c.	Fresh oil to the connecting rod system
18.031 c.c.	Circulating oil to the connecting rod system
18.32[illegible] c.c.	Circulating oil delivered to the front reservoir

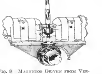


FIG. 9 MAGNETOS DRIVEN FROM VERTICAL SHAFT.

Cam-shaft and Decompression Device

The cam-shaft and rocker arms are enclosed in a bronze case containing oil. Six bosses on top of the cam-shaft enclose the cams and are bolted to the respective cylinders, ensuring great rigidity of construction. The cam-shaft case is made oil-tight with felt washers suitably disposed. The cam-shaft carries at its rear end an eccentric which regulates the air pump, whose position is indicated in Fig. 3 and which serves to maintain the pressure in the fuel tank.

The decompression device is illustrated in Fig. 10. This device forms one of the most interesting features of the motor. The bevel wheel connecting with the vertical shaft is not rigidly connected to the cam-shaft, but is carried on a hollow tube through which the shaft can be slightly displaced by means of the decompression handle, without disarranging the gearing. A cam then lifts the exhaust valve slightly.

FIG. 10. DECOMPRESSION DEVICE AND HANDLE.

The Specification of Steel*

By A. E. Berriman

Reviewed by Ernest H. Cowdrey

Instructor in Mechanical Engineering, Massachusetts Institute of Technology

The automobile has given a great impetus to the development of many of the so called "special steels" that are now and in the future will become more and more important in the construction of air craft. Unfortunately in many instances these steels have been developed under some special trade name or brand. Lately attempts have been made both in this country and abroad to put before the engineering profession some thing more definite in the form of specifications for the chemical composition of such steels. Since the set of standards recently proposed by the Engineering Standard Committee is in reality nothing more than an attempt at a uniform general classification of steels, it must of necessity be very broad in its scope and possibly only poorly applicable to steel desired for any specific use.

Chemical composition, moreover, is not the final word. There must also be taken into account those more indefinable attributes generally combined with the name of "quality." It is necessary to remember that much of what constitutes "quality" in steel appertains to detail of manufacture that cannot be recorded in the chemical compositions and is not necessarily apparent in the physical tests.

casting of the ingot and its subsequent preparation into the billets and bars of commerce on which the steel making industry might well prepare some information that would serve as a most useful supplement to the existing standards.

In mentioning the process of manufacture reference is made to crucible casting and the electric furnace, although many of the steels in the classification under discussion may be made in the open hearth or by the Bessemer process without yielding a product which can be considered in any sense inferior. The accompanying table shows the very conveniently tabulated summary of the specifications proposed by the E. S. C.

While American engineers will doubtless be inclined to follow the specifications presented by the American Society for Testing Materials, notably that of Serial Designation A 20, Year Book 1915, the E. S. C. recommendations may prove of some interest. Since these specifications are intended as a broad classification rather than specifications for steels to be used for restricted purposes, it is not surprising to find the allowable variations somewhat greater than those recommended in this country, particularly in the specifications presented by the A. S. T. M. The leniency in sulphur and phosphorus

E. S. C. STANDARD STEELS

	Case Hardening Steels									
	10" Carbon	15" Carbon	2% Nickel	5% Nickel	Carbon	Carbon	3% Nickel	1½% Nickel Chrome	3% Nickel Chrome	NC Air Hard
Carbon	.08/.14	.12/.20	.10 .15	† .15	.15 .25	.30 .40	.25/.35	.25 .35	.20 .30	.28 .36
Silicon	† .20	† .20	† .30	† .20	† .25	† .30	† .30	† .30	† .30	† .30
Manganese	† .60	.85/.10	.25 .50	† .40	.40/.85	.50 .85	.35/.75	.35 .60	.35/.60	.35 .56
Sulphur	† .04	† .07	† .05	† .05	† .06	† .06	† .04	† .04	† .04	† .04
Phosphorus	† .04	† .07	† .05	† .05	† .06	† .06	† .04	† .04	† .04	† .04
Nickel			2.5/2.50	4.75 5.75			2.75 3.50	1.25 1.75	2.75 3.50	3.50 4.50
Chromium								0.75 1.25	.45 .75	1.25 1.75

CHECK TESTS

Treatment °C	N 900/920	N 880/920	N 850/900	N 820/860	N 880/920	N 850/880	N 840/880	OH 850 T 600	OH 830 T 600	AH 830
Max stress tons in.²	23/28	28/33	25/35	25/40	26/34	30/40	35/45	*48	*45	*100
Elastic ratio %	*50%	*60%	*55%	*60%	*50%	*50%	*55%	*70%	*70%	*75%
Elongation	*30%	*28%	*30%	*30%	*28%	*25%	*24%	*15%	*18%	* 8%
Reduction	*50%	*50%	*55%	*55%	*50%	*45%	*50%	*50%	*50%	*13%
Brinell (approx.)	92/112	108/143	108/153	103/179	105/149	121/179	140/202	179	179	418

* = Not less than † = Not more than

The test bar must be heat-treated when 1⅛" in diameter. Treatment —N = Normalized OH = Oil Hardened AH = Air Hardened T = Tempered °C

The specification of high quality was not really faced by the committee responsible for drawing up the E. S. C. standard steels, and there is no doubt that useful work remains to be done in this direction by any representative group of steel makers. The absence of a quality clause in the E. S. C. specifications is no detriment to their fundamental purpose, for it must be remembered that quality is a question of degree, and therefore of price.

It is undesirable in engineering to employ steel that is unnecessarily costly for its purpose, and it would be a mistake for the standard steels arbitrarily to define only the highest quality, and therefore the most expensive class of material. It is, however, important that engineers should be able to effectively specify the highest quality when they require it.

On this aspect of the subject authoritative information is lacking at present. To say, for example, that a steel must be crucible cast is perhaps to take very arbitrary action in respect to the capabilities of the electric furnace, which may be able to produce the highest quality of steel more economically. Similarly, there are points in connection with the

limits in some cases may be indicative of a general tendency toward raising these limits. The evil effects of these elements being probably counteracted by the manganese, which is less frequently specified with us.

The writer of the article does not define "elastic ratio." While the values specified are not impossible if based upon true elastic limit, they are higher than are commonly met with in the A. S. T. M. specifications. In the case of the low carbon steels the "yield point" ratio is frequently made 50 per cent. The elongation is probably measured in a gage length of eight inches.

It must be clearly understood that the "check tests" quoted are intended to be used only as a basis of checking consignments, and do not offer data for design unless the steel is to be given a heat treatment in the finished part which will be precisely similar to that used in preparation of the specimen used in making the check test. Concerning the proper placing of the responsibility for the results of heat treatment, the writer states that in principle the responsibility for producing the results should coincide with the source of the specifications, and the appropriate source for the specification is the firm undertaking the heat treatment.

* A valuable article in *Flight*

Course in Aerodynamics and Aeroplane Design*

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and

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PART 1—SECTION 3

Elements of Aerodynamical Theory—*Continued*

Skin Friction

Skin friction may be defined as the total resistance of a thin plate moving edgewise through a fluid, and is due to two components.

(1) Viscosity resistance

(2) Density resistance

which we shall consider in turn.

In some respects skin friction is a misleading term. We shall see shortly that the skin of a body has nothing to do with the resistance, a moving body being covered with a layer of fluid at rest. Its usage, however, has been sanctioned by time.

Viscosity

Real fluids like air and water offer a resistance to shear, which is a measure of their viscosity.

FIG. 12. VISCOSITY ACTION FOR THIN SURFACES.

Let us imagine two horizontal planes one of which, AB, is at rest, as in Fig. 12, while the other, CD, is dragged past with a velocity V, with the viscous substance intervening, the distance between the two plates being c.

Particles of the substance nearest to CD will adhere to it. Other particles will drop behind along the line $yyyyy$ a constantly increasing amount xy. If F is the horizontal force per unit area required to drag CD, it is obvious that it will be proportional to some constant dependent on the nature of the substance and on the velocity gradient.

We may then write

$$F = \mu \frac{V}{c} \text{ where } \mu \text{ is some constant } \dagger$$

If V and c are units

$F = \mu$ and μ becomes the coefficient of viscosity.

The simplest case of viscous drag is that of a thin plate moving edgewise through a fluid. Length is l and breadth b. There will be a thin boundary of fluid of thickness a which connects the particles adhering to the body with the particles at rest in the fluid. This layer will continually lose and gain fluid as it is rubbed off. In unit time a mass of fluid proportional to the cross section of the layer, (ba) and to the velocity, will be captured and have its velocity partly destroyed.

The inertia force required for this change of momentum will therefore be proportional to

$$(\rho\, ab\, V)\, V \text{ or } \rho\, ab\, V^2$$

The viscous drag must be equal to this inertia force, and is itself proportional to $\mu\,(bl) \times \frac{V}{a}$ by the definition given above. And if

$$\mu\,(bl)\,\frac{V}{a} \sim \rho\, ab\, V^2, \text{ then, } a \sim \sqrt{\frac{\mu l}{\rho V}}$$

The viscous drag therefore is proportional to $\mu\,(bl)\,V \sqrt{\frac{\rho V}{\mu l}}$

$$\text{or to } \mu^{\frac{1}{2}}\, b\, l^{\frac{1}{2}}\, \rho^{\frac{1}{2}}\, V^{\frac{3}{2}}$$

Coefficients of Kinematic Viscosity

To represent the relative importance of density and viscosity a coefficient

$$\nu = \frac{\mu}{\rho}$$

is employed, known as the coefficient of kinematic viscosity. Substituting from this equation in the expression for viscous drag we obtain

$$F \sim \nu^{\frac{1}{2}}\, b l^{\frac{1}{2}}\, \rho V^{\frac{3}{2}}$$

which may be expressed in the more practical form

$$R_v = d\nu^{1.5} A_s^{0.75} V^{1.5}$$

where R_v = viscous drag

d = constant

A_s = area in shear

$A_s^{.75}$ is equivalent to $bl^{\frac{1}{2}}$ by the theory of dimensions.

Reynold's Number

It is interesting to note that the thickness of the boundary layer

$$a \sim \sqrt{\frac{\mu l}{\rho V}} = \sqrt{\frac{\nu l}{V}}$$

The expression

$$\frac{l}{a} \sim \sqrt{\frac{Vl}{\nu}} = \sqrt{r}$$

will be of use in comparing resistances for similar bodies in the same fluid.

It is known as Reynold's number and expresses mathematically a relationship between velocity, linear dimensions and viscosity. We shall have frequent occasion to refer to it in comparing resistances of stream line bodies, rods, wires and so forth.

Prandtl's Theory of the Boundary Layer

The theory of the thin boundary layer is due to Dr. Prandtl of Göttingen, his hypothesis being that the velocity gradient is at first very steep but flattens out quickly, until in the free stream the velocity gradient between stream lines

* This course commenced in the August 1, 1916 issue of AVIATION AND AERONAUTICAL ENGINEERING, will be completed in 24 issues. It will embody the fundamental aeronautical data necessary for aeroplane design, and present the design of standard machines in complete simple and systematic form.

† μ is Greek letter mu.

is negligibly small. Elaborate experiments by Dr Prandtl bear out this theory, and demonstrate that the viscous drag does indeed vary as $V^{1.5}$

Dr Zahm's experiments on skin friction on the other hand have shown that for even surfaces, bodies covered with such widely varying substances as dry varnish, wet varnish, water, sheet, zinc, etc, all experience the same frictional resistances. It seems therefore reasonably safe to assume that viscous drag is due to internal fluid friction and not to the sliding of the fluid along the surface of the solid.

Density Resistance to a Plate Moving Edgewise

For exceedingly small velocities, it has been found that resistance varies as V indicating purely a drag due to shear (Stokes). For small velocities experiments by Allen have shown a resistance varying as $V^{1.5}$ indicating the condition of viscous drag which we have developed in the preceding paragraphs. But for the velocities with which we are concerned the resistance of a thin plane surface moving edgewise increases as some higher power of V. This is probably—although it is impossible to state the exact cause—due to the fact that the viscous drag not only imparts translational velocity to the particles which adhere to it in the boundary layer but the boundary layer acting as a species of gearing also gives some eddying or rolling velocity to particles adjacent to this boundary layer. It is a commencement of turbulent,

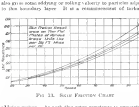

Fig 13. Skin Friction Chart

eddying motion. As such this extra resistance is proportional to some area A of the body, and to the velocity V, squared, and is termed density resistance and

$$R_d = K A V^2$$

where K is a constant for the fluid

Total Skin Friction. Dr. Zahm's Experiments

$$\text{Total skin friction} = R_t = R_v + R_d$$
$$= \text{viscosity resistance} + \text{density resistance}$$

Strictly speaking if $R_v \sim V^{1.5}$ and $R_d \sim V^2$ no one expression with V raised to a power n can satisfy this expression. But for practical purposes the results of Dr Zahm's valuable experiments have been accepted, his formula being:

$$R = 0.00000778\, l^{.93}\, V^{1.85}\, b$$

where R = resistance for one side of board
l = length in direction of wind in feet
b = width in feet
V = velocity in feet per second

In the British Technical Report of the Advisory Committee for Aeronautics, 1911-1912, p. 34, an alternative form of equation has been submitted, so as to make the equation consistant with the principles of dynamic similarity:

$$R = 0.0000082\, A_s^{.93}\, V^{1.86}$$

where A_s = area of one side of the board in square feet

Amongst other applications, Dr Zahm's formula may be used to compute the resistance of flat rudders, elevators, and stabilizers when neutral to the wind. In Fig. 13 curves for the resistance of plates of various area at varying speeds have been plotted, to facilitate such computations.

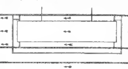

Fig. 14 Arrangement of Thin Plate in Wind Tunnel in Dr. Zahm's Experiments.

Dr Zahm's skin friction experiments are described in *Bulletin,* Vol xiv, pages 247-276, of the Philosophical Society of Washington, June, 1904. The plane was suspended in the wind tunnel as shown in sketch in Fig. 14, with wind shields at either end so as to give purely tangential forces. As the wind friction moved the plane edgewise the displacement was determined by the motion of a sharp pointer attached to one suspension wire and traveling over a fine scale lying on the top of the tunnel, and hence the forces were deduced. A variety of shapes and surfaces were tried

Curves for Computations with Dr. Zahm's Formula

In Fig 13, the skin friction resistance in lbs per square foot is plotted against the speed in miles per hour. Since the resistance increases less rapidly than the area, separate curves have been drawn for several different areas, and the force per unit area on any other surface can be found by interpolation. The curves were plotted by modifying Zahm's formula

$$R_r = 0.0000082\, A^{.93}\, V^{1.86}$$

where V is in feet per second. To throw this into miles hour units it was necessary to multiply by $\left(\frac{88}{60}\right)^{1.86}$, or 2.04, giving

$$R_r = 0.0000167\, A^{.93}\, V^{1.86}$$

In Tables 1 and 2 similar data has been given for speeds in feet per second and miles per hour

TABLE 1.—SKIN FRICTION RESISTANCE

Speed (feet per second)	Area (sq. ft.)							
	1	5	10	15	20	25	30	35
30	0045	020	039	056	074	091	108	124
40	0078	035	067	097	127	156	185	210
50	0119	053	101	147	193	240	280	330
60	0165	074	141	210	270	330	390	450
70	022	098	189	280	360	440	520	610
80	028	127	240	350	460	570	670	780
90	036	156	300	440	580	710	840	970
100	043	192	370	530	700	860	1 02	1 18
120	060	270	510	740	970	1 19	1 42	1 65

TABLE 2.—ZAHM'S FORMULA

$R = 0.0000162\, A^{0.93}\, V^{1.86}$ V = miles per hour

Speed (miles per hour)	Area (sq. ft.)							
	1	5	10	15	20	25	30	35
30	0094	041	080	114	151	186	220	250
40	0159	071	137	198	260	320	380	430
50	024	108	210	300	390	490	570	650
60	034	154	290	430	550	670	800	920
70	045	200	390	570	730	900	1 06	1 24
80	057	260	490	710	940	1 16	1 37	1 59
90	073	320	610	900	1 18	1 45	1 71	98
100	088	390	750	1 08	1 43	1 75	2 08	41

Turbulent Flow, Eddy or Density Resistance

We have already seen in the case of a flat plate normal to the wind that the resistance was due to a region of turbulent, eddying low pressure behind the plate. This resistance varies as $\rho A V^2$

where A = area in normal presentation
ρ = density
V = velocity

It will be assumed for the time being that wherever there is a region of turbulent, eddying flow, there will be a density resistance

$$R \sim \rho A V^2$$

A fairly complete demonstration of this has been given by a French author, and will shortly be reproduced in the columns of this paper

Comparison of Forces Acting Upon Similar Bodies. The Importance of Kinematic Viscosity and the Reynold's Number

For the comparison of forces acting on similar bodies, a knowledge of the geometric proportions and of the wind velocities is insufficient. The density of the fluid, the viscosity and hence the coefficient of kinematic viscosity and the compressibility of the fluid all enter into the complete comparisons

Compressibility, we have seen, may fortunately be neglected in all aerodynamical work

For bodies in which the resistance is purely of a density or eddy making nature—as in the case of a flat plate normal or inclined to the wind, and as we shall see subsequently in the case of a wing section at large angles—viscosity does not enter into consideration, or is of so small importance that it may be neglected. In such cases

$$R \sim \rho A V^2$$

where A is the area of one face of the plate comparison between two bodies such as a full sized wing and its model become extremely simple

But for stream line bodies such as struts, cables, wires, and cylinders the resistance is compounded of density resistance and viscosity resistance in varying proportions.

Viscosity resistance depends, as we have seen, on velocity, linear dimensions and the coefficient of kinematic viscosity. For such bodies therefore the resistance must be expressed in a form involving these variables, and by the principle of dynamic similarity it can be demonstrated that

$$R = \rho\, l^2\, V^2 f\left(\frac{lV}{\nu}\right)$$

where f is some unknown function and l^2 is of the same dimensions as A. The $\rho\, l^2\, V^2$ brings out the density resistance, $f\left(\frac{lV}{\nu}\right)$ the viscosity resistance; since $\frac{lV}{\nu}$ = the Reynold's number r, we can write

$$R = \rho\, l^2\, V^2 f(r)$$

The reader will now appreciate the importance of the Reynold's number in comparing the resultant forces on the above mentioned bodies.

It is quite incorrect to compare such bodies, making allowance for variation in l^2 and V^2 only unless the Reynold's number is the same for the two bodies under comparison.

In practice it is very rare that comparisons of forces are made with reference to two different fluids. We are almost solely concerned with bodies in air. The coefficient of viscosity becomes a constant, and instead of considering the Reynold's number, we can drop the ν and compare bodies having the same product lV.

Stream Line Bodies

A stream line body may be defined as one which has a gradual change of curvature along any section, and which

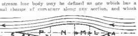

Fig. 15. Lines of Flow for a Stream Line Body

when moved through air or water at ordinary speeds makes little disturbance or turbulent wake. Such a body moving in a viscid fluid would experience mostly frictional resistance.

Energy Considerations for a Perfect Fluid Flowing Past a Stream Line Body

It is most useful to have a definite idea of the exchange of energy which occurs in such a case. The first treatment appears to have been given by W. Froude

Imagine the fluid in the vicinity of the body to be divided up into a large number of imaginary tubes of flow. Well ahead of the body where the stream is as yet undisturbed the energy of the fluid will be that due to the static pressure p_0 of the stream and the kinetic energy head of V_0, the undisturbed velocity. In a perfect fluid this will remain a constant along any tube of flow by Bernoulli's theorem, and is equal to

$$\frac{p_0}{\rho} + \frac{V_0^2}{2g} = c = \frac{p}{\rho} + \frac{V^2}{2g}$$

For the portion L, as shown in Fig. 15, of the body, the tubes

Fig. 16. Motion Around a Stream Line Body.

of flow widen out, the velocity and the kinetic energy head diminish and the pressure on the body becomes greater than the static pressure p_0. The nose of the body therefore does work upon the fluid in contact with it. This is also evident by considering the effect of curvature and the centrifugal force resulting from it. For the portion M the tubes crowd together, the velocity increases and the body is under the action of a pressure less than p_0—it is really under suction and the fluid does work on the body. By similar reasoning it can be shown that the portion N the body works upon the fluid, and for the portion P, the fluid works upon the body. The balance of work done on the body is thus found to be zero.

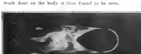

Fig. 17. Flow for a Short Strut

Stream Line Bodies in a Viscous Fluid

At slow speeds in water almost perfect stream line motion has been observed and recorded by Dr. Ahlborn (see Fig. 18). But at ordinary speeds even with stream line forms there is

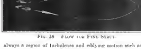

Fig. 18. Flow for Fine Strut

always a region of turbulence and eddying motion such as we have already observed in the case of the flat plate, accompanied by a surface of discontinuity between the main stream and the turbulent region. The eddying motions are in part due to pressure differences in the undisturbed stream and the region behind the body, in part due to viscosity. The exact theoretical investigations of the causes at play are unimportant

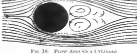

Fig. 19. Flow Around a Cylinder

from the designer's point of view. It is more important to notice that just as in the case of the flat plate, this turbulent region will be a region of low pressure and will introduce a density or eddying resistance.

This density resistance for a stream line body may be said to increase with the extent of the turbulent region. Thus in Figs. 17 and 18 depicting two standard struts, the finer strut has a smaller turbulent region and considerably less resistance. On the other hand, as the fineness ratio, or the ratio of length to maximum thickness, of a stream line body increases, the area in shear and the viscosity drag increase also; the fineness ratio must be kept within reasonable limits even from a purely aerodynamic point of view.

Fig. 20. Flow for a Cambered Wing at 2°

Resistance of Wires, Cables and Cylinders

Fig. 19 represents diagrammatically the fluid motion round a cylindrical body, such as a wire or cable, at usual aeroplane speeds.

It is obvious that the resistance will be partly due to viscosity over the front part of the cylinder and partly due to eddy or density resistance. The forces in action will therefore be represented as previously stated by an expression of the form

$$\rho l^2 v^2 f(r)$$

And two wires or cables will only be comparable when r is the same for both or simply when the product lV is the same.

Fluid Motion Around Wing Surface

It is to Langley, above all other men, that we owe an appreciation of the value of cambered surfaces. A good wing section may give a lift drift ratio of 18 as compared to the 6 or 7 of a flat plate, and it is the remarkable efficiency of a wing surface which has largely rendered aviation possible.

In wing surfaces, we recognize two distinct types of flow. For the small angles up to 6° or thereabouts a steady flow as shown in Fig. 20 for a typical aeroplane wing. At this angle—often termed the first or lower critical angle, turbulence begins. At 10°, as shown in Fig. 21, this turbulence is quite considerable. Finally a second critical or "burble point" is reached at 18° for the same wing. Here an extremely turbulent type of

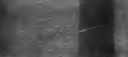

Fig. 21. Flow for a Cambered Wing at 10°

motion, as shown in Fig. 22 is found, and the lift of a wing attains its maximum. Beyond this "burble point" the motion becomes extremely unsteady and the lift decreases.

The lift of a wing, as experiment shows, varies directly as ρAV^2, with a different coefficient for every angle of incidence.

Where turbulent flow is present this is readily explainable, as in the case of the flat plate, on the hypothesis of low pressure region at the back of the wing.

It is the lifting power at small angles and in a condition of steady flow that offers theoretical difficulties. The most likely explanation is offered by Kutta's theory or the vortex theory of sustentation. We shall reserve the full treatment of this theory also to a special article, contenting ourselves with the barest outlines.

Fig. 22. Flow for a Cambered Wing at 18°

An aeroplane wing in steady flow gives of a series of trailing vortices as depicted diagrammatically in Fig. 23. These vortices are constantly destroyed and renewed. The circular motion in those vortices and their interaction is such that—as the hydrodynamical theory demonstrates—they have a downward momentum, and action and reaction being equal, the aeroplane wing receives an upward momentum.

The drift or drag of a wing is for all practical purposes taken as varying directly with AV^2, with a different coefficient for every angle of incidence.

At high angles of incidence, the drift is almost entirely a component of the density resistance, and we see that what is taken to be the case in practice, is also theoretically correct. But at small angles and steady flow the resistance is more of a viscous nature, more akin to skin friction. And skin

Fig. 21. Aeroplane Wing with Trailing Vortices

friction, as we have already seen, varies as $V^{[illegible]}$, and depends also on the dimensions of the body. This introduces considerable difficulties, as we shall see later, in computing resistance in actual flight from small model experiments at low speeds.

As to the form of wing giving the best results, no general laws are yet available, and each type of wing must be considered separately.

This section constitutes but a brief introduction to aerodynamical theory, but will perhaps assist the reader in the appreciation of the extensive aerodynamical data which we shall present later.

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Photographic Investigation of the Flow Round a Model Aerofoil, Relf. British report, 1912-1913, No. 76.

These papers in the British report contain some beautiful and instructive photographs.

Physics Notes

By W. R. Bass, Ph.D.

Discontinuous Fluid Motion Past a Bent Plane with Special Reference to Aeroplane Problems. G. H. Bryan and Robert Jones. (*Proc. Roy. Soc.*, 91, pp. 354-369.) The investigation is based on the Kirchoff-Helmholtz theory of discontinuous stream line motion of a fluid moving through an orifice or past a barrier. Integrals are obtained giving the lengths of and the thrusts on the planes. It is shown how these integrals may be evaluated exactly, but the reduced expressions are so long that they cannot well be applied to special cases. By means of approximate methods shorter reduced values are obtained. These results are used to find the lift and drift on the surface of planes. The relative advantages of planes bent at different angles and along different lines are also considered. The numerical results are not strictly quantitatively correct, since the fluid is assumed frictionless and incompressible and the motion is supposed to be two dimensional, which assumptions are not true for actual fluids. Applications to planes of more than one bend are also considered. The following conclusions are drawn from the quantitative results: Both lift and drift are largest when the angle between the planes is largest. This evidently points to the fact that the ratio of lift to the area of the plane increases with the angle of bend. The ratio of lift to drift is greatest when the angle between the planes is least. It is also seen that as the length of the front plane increases, the total lift decreases, whereas the ratio of lift to drift increases. Combining the above conclusions, a plane with a large bend close to the front edge gives the best ratio of lift to surface, while a fairly flat plane bent near the rear edge gives the best ratio of lift to drift. All these conclusions show that a distinct advantage is gained by using a cambered plane.

On the Cooling of Cylinders in a Stream of Air. J. A. Hughes. (*Phil. Mag.*, 31, pp. 118-130.) Cylindrical tubes of different diameters were placed in a current of air generated by a fan, the velocity of the wind being measured by experiments with a Pitot tube and gauge. Steam was passed through the tubes and the heat lost was measured by the weight of condensed steam. Conclusions show that at all velocities the loss of heat per centimeter length varied with $d^{[illegible]}$, that at different speeds, the loss varies with V^n, where n increases from 0.55 for the smallest cylinder to 0.98 for the largest. Experiments were also made with a stream line tube showing the heat loss to be slightly greater than for a cylindrical tube of the same total area and much greater than for a tube of the same maximum thickness. Also the loss was greater when the blunt end faced the wind.

The Aero Club of America's Work for Adequate Aeronautical Preparedness

The Aero Club of America has issued the following summary of the work done in connection with the National Aeroplane Fund, which gives, in condensed form, a splendid review of the work for the last year:

(1) Both Houses of Congress have passed the appropriation of $13,281,666 for aeronautics for the Army, National Guard and Aerial Reserve Corps, recommended by the Aero Club of America, which represents an increase of over $12,000,000 over what the Secretary of War had asked for and the House Committee on Military Affairs had allowed.

(2) The efforts of the Aero Club of America also brought an increase of $1,500,000 in the Naval appropriation for aeronautics, making the total allowed $3,500,000 and may bring $1,500,000 more for the Aerial Coast Patrol.

(3) The authorization by President Wilson of the organization of the Aerial Reserve Corps under the Army was done upon our recommendation, to utilize some of the 3,000 volunteers for the air service whose names we transmitted to the War Department in the past month. The Aerial Reserve Corps provides for training 296 officers and 2,000 men.

(4) The First Aero Company of the New York National Guard, which was organized with funds raised through our National Aeroplane Fund, has been mustered into Federal Service with forty-five officers and men and four aeroplanes. The Second Aero Company, New York National Guard, is formed and waiting to be mustered in.

(5) The aviation sections of the First and Second Battalions, New York Naval Militia, are encamped at Bay Shore, L. I., flying daily the aeroplanes presented as a result of our efforts.

(6) The Rhode Island Naval Militia has received delivery of its first seaplane, presented through the National Aeroplane Fund, and the Aviation Detachment is being organized. A training aeroplane has also been purchased for the land Militia of this State.

(7) Aviation sections and aero companies have been and are being organized under the auspices of the Militia and aero clubs in a dozen States.

(8) Thirty officers of the National Guard of as many States whose expenses while training in aviation were paid by the National Aeroplane Fund, have been mustered into Federal Service. As it required eight years for the Army to get thirty aviators, this is a valuable contribution.

(9) F. T. Davison, Robert Lovett, and ten other young men of representative American families are training in aviation to form a unit of the Aerial Coast Patrol on Long Island, twenty Harvard men are learning to fly at the Buffalo and Ithaca aviation schools.

(10) To supply trained civilians to make up the Army's deficiency in aviators, a patriotic, prominent member of the club is paying for the training of a selected group of men at Governor's Island. This training school has already four aeroplanes.

(11) The Senate has approved the plan to use aeroplanes in the Coast Guard—for the life-saving service and revenue-cutter service—which has been recommended by the club since 1911. It will give to the Navy a valuable reserve of trained aviators, who will be employed daily for peaceful purposes.

Aero Club of Pennsylvania

The next meeting of the Aero Club of Pennsylvania will be held on Friday evening, September 15, at the Bellevue-Stratford Hotel, Philadelphia. Permanent hangar plans and estimates will be considered, and possibly the contract awarded. All interested in aviation and members of other clubs visiting Philadelphia are invited to be present.

The Philadelphia School of Aviation has graduated S. H. Noyes of Newport, R. I. The test required of all candidates is to make two consecutive flights at the aviation field at Essington. In the first flight, the student must make five figure eights and finish up at Billingsport, N. J., a distance of five miles. The second flight must be made immediately after completing his first one. In it he is required to make an altitude of at least three hundred feet, and then make the return trip at Essington. These flights are conducted under the supervision of Robt. Glendinning, president of the school.

The Boughton machine while being assembled on the League Island field of the Aero Club came to grief before its trial flights, when a new Sloane tractor crashed into it and wrecked both machines. The Boughton plane had been under construction for the past eight years. Its planes are of aluminum sheets supported by rods of the same material and no stay wires are used in the entire construction. It will probably be several months before it is in shape for testing. This machine, which is said to weigh 2,300 pounds, is equipped with a 90 horsepower Curtiss motor. Mr. Boughton is confident that owing to the fact that the propellers are pivoted the aeroplane will attain a greater thrust and lift than on the ordinary type.

George C. Thomas, one of the pupils of the Philadelphia School of Aviation, started his career as an expert pilot after driving his Curtiss flying boat over the Essington to Atlantic City route in one hour and forty-five minutes. It is said that Mr. Thomas is so enthusiastic that he will build a hangar near his Ventnor City home and use his flying boat for traveling between Philadelphia and Atlantic City.

Congress Is Urged to Pass the Aerial Coast Patrol Bill

Acting on the recent advice from Congressman Lemuel P. Padgett, Chairman of the House Committee on Naval Affairs, that there would not be time at this session to consider the bill for the establishment of an Aerial Coast Patrol, advocated by Rear Admiral Robert E. Peary and indorsed by President Wilson and other prominent government officials, the Aero Club of America has appealed to the President to have the bill considered before the end of the session.

In the appeal to the President, Alan R. Hawley, president of the club, pointed out that no appropriation had been allowed for aviation in the naval militia, and that the appropriation for naval aeronautics in the Naval Appropriation bill was only half the amount asked by the General Board of the Navy. In consideration of this Mr. Hawley showed that the appropriation of $1,400,000 for the Aerial Coast Patrol bill was badly needed to facilitate training and equipping of civilian aviators in connection with the naval militia of the twenty-two States which maintain such organizations.

The Aerial Coast Patrol bill which was introduced in the Senate by Senator Charles F. Johnson, and in the House by Congressman Julius Kahn, would connect the patrol with the naval militia and put it under the direction and control of the Secretary of the Navy. It provides for furnishing the naval militia of each State with a suitable course of instruction, one or more hydroaeroplanes and a corps of competent instructors. A number of States have taken measures to organize units in the Coast Patrol.

Michigan National Guard's Machine Wrecked by Storm

On August 18 the L. W. F. aeroplane which was presented to the Michigan Aviation detachment by the Aero Club of Michigan was injured in a wind storm which did great damage in Camp Ferris. The machine was blown into the lake and turned over several times. The monocoque fuselage stood the tossing without injury.

The Michigan National Guard's Wrecked Aeroplane

Military Training School Sites

Col. W. A. Glassford, U. S. A., in command of the U. S. Aviation School at North Island, in a recent speech is quoted as giving the following qualifications for a military aviation station. His opinion is of the greatest interest, as the government will in the near future have to select sites for this development of military training.

"An aviation training school should be located where flying can be carried on every day in the year and as many hours of the day as possible. The northern part of the United States with its cold and stormy winters, also districts further south that have mild winters but periods of storms of wind and rain, also places having great heat during summer, are unsuitable.

"The surrounding country should not be broken by nearby high elevations that would break up the air currents or direct them in streams over the aviation field. The immediate environs should be unbroken by high hills, buildings, forest trees or other obstacles that would break up the air currents and cause gusts or choppy air. The poles of electric lines are dangerous when near a training field.

An aviation installation should be near a large city where good railway transportation facilities are present and where various supplies can be quickly purchased. Proximity to a city permits employes, officers and enlisted men to be quartered comfortably and economically.

"To facilitate training for the aero defense of our coasts, insular possessions and Panama, an aviation school should be situated adjacent to a sheltered bay, but not on the shore of the open ocean where breakers would interfere with launching of flying boats and hydroaeroplanes. This bay should be large enough to permit the operating of many machines at the same time without interfering with one another. It should also be away from tide flats and water should be deep enough to permit rescue boats moving near the shore. A river is not suitable for water training.

"Meteorological conditions are of prime importance. Winds should be light the year round. They should also be regular in force and quite constant in direction and not subject to local disturbances due to outlying mountains or high hills and adjacent desert areas. Proximity to an ocean in low latitudes creates regularity of wind flow. Districts outside the path of cyclonic storms and where tornadoes and cold waves do not occur are most favorable. Districts where thunderstorms are frequent are dangerous.

"An aviation training ground should afford facilities for both land and water instruction. Shallow water close to the shore line and extensive tide flats about an aviation training ground make forced landings unsafe. The site should be where hangars for land and water machines can be adjacent, also close to machine shops, storerooms, barracks and all equipment that is common to both. An island where surrounding water prevents the future erection of buildings, chimneys, telegraph, telephone and power lines is most favorable.

"The training field should be level and open so as to permit forced landings anywhere within a considerable radius. An entire island gives a most central situation for forced landings and the surrounding water gives chances for quick rescue of machines falling into the water.

"The soil should be sandy, thus free from sticking mud after a rain.

"The larger the field the better and under conditions such as are likely to obtain within the next few years the area should be not less than a thousand acres, or approximately two square miles.

An island, most of which borders a wind-protected bay, permits of a great number of machines in the air at the same time without interfering with each other.

"An aviation school should be well defended from an enemy's approach, especially by water. The guns defending a seaboard city and the navy which rendezvous in its bay afford the best protection that can be selected upon a littoral. As aircraft is a part of the coast defense, aviation installations should be in close proximity to such defenses.

"A training camp should be situated in the neighborhood of military defenses, mines, submarines, etc., so that aviators may become familiar with taking a bird's-eye view of these objects."

Carlstrom in the Lead for Curtiss Trophy

Carrying one passenger and flying a Curtiss J. N. twin-tractor, a combination land and water machine, Victor Carlstrom, on August 25 set a new American distance record for flying when he covered 661 miles in 8 hours and 40 minutes. This is a new record for distance covered in one day, and, unless the mark is bettered, Carlstrom will win the Curtiss trophy for this year. The trophy was won last year by Oscar Brindley in a Martin military tractor hydroaeroplane, with a flight of 554 miles in ten hours, flying without a passenger. In addition, Carlstrom will receive $7,000 for his flight, this amount being offered as a bonus by Glenn H. Curtiss to the winner of the trophy.

The flight was made over a course from Newport News to Fisherman Island near Cape Charles, a distance of fifty-one miles for the round trip. Besides losing time by making turns at each end of the course, Carlstrom was under the additional difficulty of steering by compass because the weather was thick and objects could be sighted only a few hundred yards away. Charles Kirkham was the passenger. Carlstrom started out to make 700 miles in ten hours, but carburetor trouble on one occasion and two stops to replenish his gasoline supply cost him 1 hour and 20 minutes.

One hundred and forty gallons of gasoline were used on the trip, which amount is said to be small, as the machine is equipped with two engines of 110 horsepower each. Carlstrom at times reached a speed of about ninety miles an hour.

IT IS REPORTED THAT—

MISS NORMA MACK, the daughter of Norman E. Mack of Buffalo, made an aeroplane trip with LIEUT. PHIL RADER from the Curtiss Aviation School to Niagara Falls on August 24. They spiraled over the Falls, and Miss Mack, after the trip, said that flying was so delightful that she thought she would learn to fly herself.

(C) International Film Service, Inc.

Miss Norma Mack and Lieut. Phil Rader, Who Flew Over Niagara Falls

DR. GEORGE S. KING of Bayshore, L. I., flew in a hydroaeroplane to visit a patient who needed his services. He had to cross Great South Bay quickly to his patient on Fire Island and as no motor boat was available, he took the air route.

JOE BOQUEL made thirty successive loops at Tanforan Park, San Francisco, on August 6. This is the greatest number of loops on record.

WILLIE RITCHIE, the pugilist, has qualified for a lieutenancy in the U. S. Aviation Reserve Corps at Monterey, Cal. He hopes to become as famous as the other boxers who have become aviators. GEORGES CARPENTIER, the French heavyweight, has been flying since the beginning of the war, and LES DARCY, the Australian fighter, is in the Australian Aviation Reserve.

MRS. H. P. DAVISON of Port Washington, L. I., has taken an interest in aviation on account of her son, Trubee Davison's desire to join the Aerial Coast Patrol. H. P. Davison, Jr., another son, who is now with the American Ambulance Corps in France, expects to return in the fall and also join the school which Mr. Davison is maintaining for the training of a group of young men who are well known in New York.

HARRY JOLINE of Philadelphia, aged four, took a trip with AVIATOR KENNETH JAQUITH of Atlantic City, giving him the title of the youngest aviation passenger.

BION J. ARNOLD of Chicago is taking an active interest in the U. S. Central Aviation Reserve. Recently he went to Washington to make arrangements for its official recognition.

ROLLAND KITE of Springfield, Mo., is building a biplane which he hopes to complete in a few weeks.

CAPT. BENJAMIN D. FOULOIS, U. S. A., and CAPT. FRANK P. LAHM, U. S. A., aviation officers of the Signal Corps, have been promoted to Junior Military Aviators, with the rank of major. Both officers have been connected with the aviation service since its infancy.

CHARLES BROADWICK of Los Angeles is experimenting with parachutes for aeroplane uses. He recently dropped T. T. MARONEY 1500 feet from his machine. The parachute is fastened like an ordinary campers' pack to the back, and the passenger is dropped from the machine by a trap seat.

CAPTAIN AUGUSTIN PARLA, of the Cuban army, has arrived in New York to make an investigation of military aviation with a view to establishing an aeronautic school for Cuban army officers. He will remain in the country for six months. Captain Parla is himself an aviator of experience. In 1913 he won the Glenn H. Curtiss medal by flying from Key West to Mariel, Cuba, a distance of 117 miles, without a guide or an accompanying vessel. He will be in Buffalo for the greater part of his stay here, taking up hydroaeroplane work, and will also visit all the aviation schools in the East. He was ordered here by General Jose Marti, chief of staff of the Cuban army. He was accompanied by his wife, who but recently celebrated her sixteenth birthday.

TEX MILLMAN was at the wheel of the plane used in making The Eternal Question, the five-part production in which Madame Petrova is starred. Millman flew from Staten Island out over New York lower bay. Besides Mahlon Hamilton, Madame Petrova's leading man, Millman carried a camera man in his machine. He made several dips down over steamers bound for sea, searching for the one carrying Madame Petrova, who in the story was being abducted. When the vessel sought was found Millman circled around the forward mast, and Hamilton, lowered by a rope, grasped the mast and climbed down on the deck. There a struggle with the crew resulted, and Hamilton was overcome.

COLONEL MAX C. FLEISCHMANN of Cincinnati had a narrow escape from death on August 27 when his hydroaeroplane fell and was wrecked in Point Judith Salt Pond, near Narragansett Pier, R. I. When Colonel Fleischmann was about 150 yards from shore and flying at a moderate height, preparing to land, his machine dipped, and the right wing went into the water first, then the left wing, and after that the machine collapsed. He was carried under the engine of the hydroaeroplane, and from this perilous position he was rescued and taken to his cottage at the Pier, where it was found several ribs were broken. During the summer he has made several notable flights over Narragansett Bay.

J. E. O'DELL of Waterloo, Canada, proposed to prepare for the future by maintaining an aeroplane garage. He is to have a flying field and hangars as well as the machine shop.

CAPT. PHIL BILLARD of Topeka is considering opening an aviation school. He hopes that the aeroplane under construction by A. K. LONGREN of Topeka will be ready for its initial tests shortly.

MAYOR CURLEY of Boston has issued the first aeroplane license in the history of the city to JEAN DOMENJOZ, the Swiss aviator, who flew over Boston and circled the Custom House tower. The Boston police were in a predicament over this flight. As Domenjoz flew over several towns before he reached the city, the police of one place were waiting for the police of the town crossed earlier in the flight to act. The State Board of Highways requires all aviators flying in Massachusetts to be registered, the fee for which is five dollars. For his aeroplane with its 60 H. P. Bleriot motor, a ten-dollar fee was paid the State. The city also required a fee of ten dollars.

Mrs. Waldo Peirce Is an Air Pilot

Mrs. Waldo Peirce, painter, sculptor, and musician, has passed all necessary flying tests at the Wright Flying School near Mineola, Long Island, and has obtained her license as an air-pilot.

Mrs. Peirce, perhaps better known by her maiden name, Dorothy Rice, is a daughter of the late Isaac L. Rice, the inventor. Her husband is serving with the American Ambulance Corps in France, and it was with the idea of joining him at the front that Mrs. Peirce first took up aviation. She hopes now to qualify as a military aviator.

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Mrs. Waldo Peirce, the Air Pilot

New Hydro Flies Successfully

First of a number of new seaplanes—complying in every detail with government specifications for the latest approved type of fighting aircraft—the "Number One" seaplane of the Pacific Aero Products Company was given its air and water tests August 19, with Aviator Knox Martin in the pilot's seat.

The tests were satisfactory in every respect, giving basis for the belief that when the time comes for government tests each and every one will be complied with with a big margin of efficiency to spare.

It is powered by a 125-horsepower Hall-Scott engine. The landing gear is equipped with two turtle-back pontoons and the body contains space for pilot and observer. The pontoons, of special construction, "plane" easily and in lifting from the water and returning to that element, do so freely and without the annoying bumping and pounding common with the flat or "boat" pontoon.

With President W. E. Boeing of the Aero Products Company, and G. C. Westervelt as spectators, Aviator Knox Martin tested the big machine. For a trial of her engines, he took the plane down to the southern end of Lake Union, wheeled about and in another second was off the water and rising rapidly into the air. While testing his controls he performed some evolutions with the big plane banked under full power to prove there was no sideslip, descended almost to the surface, and then zoomed at a dizzy angle half banked over as a show of the craft's climbing power.

Martin circled the lake three times, coming down in the teeth of a stiff wind which had sprung up, and alighting on the surface of the water most gracefully. Two minutes later, without the use of more power he drifted to the precise landing point on the launching apron from which he had departed.

Government tests will follow in the near future in order to comply with all federal requirements.

"I dislike to talk of what I am going to do," said Mr. Boeing after the flight, "it is far better to talk of what has been done. But I will say I hope for great things for our new model machine, and will be greatly disappointed if it does not prove available for defensive purposes."

HALL-SCOTT POWERED TYPE S MARTIN SEAPLANE
Four of these machines with duplicate power plants form the Philippines Squadron. These equipments have been in service during the past six months, and are said to have given excellent results

L. W. F. Engineering Company Elects New Officers

Joseph Osler, president of the Fifth Avenue Bond and Mortgage Company, 505 Fifth Avenue, New York, announces that the new officers elected during August of the L. W. F. Engineering Company, of which he is also president, are: Albert H. Flint, vice president and general manager; M. J. Murray, secretary and treasurer. With these three officers, L. D. Tompkins and Edward Lowe, Jr., will act as directors. The work of the company is progressing rapidly, and at the plant at College Point ten machines are in the process of assembling, some for army orders.

New Directors in Curtiss Company

George F. Rand, John C. Clawson and Walter S. Cook have been elected directors of the Curtiss Aeroplane and Motor Company. The executive committee has been enlarged and will consist of Glenn H. Curtiss, John C. Clawson, George F. Rand, Walter S. Cook, and Monroe Wheeler, all of Buffalo. G. C. Houston of Jamieson & Houston has been appointed general manager of the company, succeeding K. B. McDonald, who will go to Europe as special representative of the company.

Fowler and Willard Forming Company

Robert G. Fowler and Charles F. Willard, pending the formation of a new company in which they will be interested, are actively engaged in bringing out a new model machine for army and navy uses. They are located with their engineering staff at 1105 Times Building, New York.

B. R. Shaw Incorporates

The Shaw Aeroplane and Motor Company of Indianapolis has been incorporated with the following officers: B. R. Shaw, president; F. G. Cathrall, vice president; W. M. Cathrall, treasurer, and B. L. Shaw, secretary.

TRADE NOTES

E. NICKERSON and CHARLES M. PETERS are located at the aviation field in Minneapolis. Mr. Nickerson has just completed a new tractor biplane of his own design.

The WRIGHT FLYING FIELD, INC., 60 Broadway, New York City, has issued an attractive booklet called "The Wright Flying School," which is profusely illustrated with attractive views and pictures of various styles of Wright machines and a map of Long Island.

The INTER OCEAN STEEL PRODUCTS CORPORATION, 165 Broadway, New York, has taken over the M. F. P. AERO SALES CORPORATION. J. Brooks Clarke has been elected director and president.

The CALIFORNIA AEROPLANE COMPANY is maintaining a service to the Dolly Varden mine in the Alice Arm district of British Columbia. This service has prevented the shutting down of the mine, and it is reported that the aeroplane makes two trips daily carrying supplies to the mine and ore back. The distance is fourteen miles.

NOAH SMITH of San Angelo, Tex., is building a monoplane which he hopes to be able to supply to sportsmen at a very low price.

HERBERT B. GILLETTE of Grand Rapids has invented an aerial torpedo which he claims has great possibilities in warfare. He is negotiating with foreign governments for its sale.

Meteorologist Suggests Aeroplane Trip to Asia

Dr. Ford A. Carpenter, meteorologist, U. S. Weather Bureau, Los Angeles, Calif., who is now making a climatological survey in the Los Angeles district, has made the interesting suggestion that a trip to Asia by aeroplane from San Diego would be feasible because of prevailing air currents, though the return journey would have to be made by a much more northerly route. Dr. Carpenter tells an interesting story of Chanute, who while at San Diego took hundreds of photographs of the flight of pelicans over the bay, and who told Dr. Carpenter subsequently that the first Wright biplane was an imitation of the pelican.

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Sperry Searchlight Is Seen Fifty Miles

The new Sperry searchlight on the top of the Sperry Building, Brooklyn, N. Y., while being recently tested, is reported to have been visible at a distance of fifty miles. This 1,280,000,000 candle power light has been constructed by Elmer A. Sperry, the inventor of the gyroscopic stabilizer. Although it weighs three tons and its front is nine feet in diameter, it is operated by one person. The beam near its source is claimed to be of such intensity that a pile of rubbish two hundred feet away has been set on fire by its rays. When mounted near the sea level, a vessel can be clearly distinguished as it appears on the horizon.

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The chief features of this machine as supplied by the manufacturer are as follows: Span top plane, 34 feet, span bottom plane, 26 feet, cord, 5 feet, gap, 5 feet, master depth of body, 38 inches, width, 26½ inches overall, fuselage length, 22 feet.

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